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# Cancer Mortality Excess in Counties of Missouri, Iowa, Nebraska, and Kansas Part 1. Report

Kansas Univ. Coll. of Health Sciences and Hospital, Kansas City

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Cancer mortality rates were calculated for white residents of 412 counties in Missouri, Iowa, Nebraska, and Kansas for the 1968-1977 period. Comparisons were made to data from the National Cancer Institute for the 1950-1969 period. The principal purpose of the study was to look for consistently high rate cancer mortality "hot spots". Recommendations were to be made to EPA as to further environmental and epidemiologic research studies needed. It was concluded that a lung cancer cluster in the old lead-zinc mining areas of Missouri, Kansas, and Oklahoma deserved further investigation.

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# CANCER MORTALITY EXCESS IN COUNTIES OF MISSOURI, IOWA, NEBRASKA, AND KANSAS

## PART I REPORT

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September 1, 1981

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## SUMMARY

Analysis of cancer mortality for white residents of Missouri, Iowa, Nebraska, and Kansas was completed for 412 counties and 45 county groups for the periods 1968-1972 (Kansas excluded) and 1973-1977. Age specific cancer mortality rates were calculated using the 1970 and/or the 1975 populations in the denominator. Age adjusted rates were then calculated using the direct method, with the total 1960 U.S. population as the standard. Rates were rank ordered by county or county group for each cancer site. Rates calculated during the periods 1968-1972 and 1973-1977 were compared to previously published results (National Cancer Institute, 1950-1969) to look for consistently high statistically significant results.

Table 1 and Figure 1 summarize the cancer mortality excess found consistently high in each state at the county or county group level for both 1950-1969 and 1968-1977 (1973-1977 in Kansas). In Missouri, excesses are seen for males in total and colon cancer in St. Louis County and St. Louis City. Lung cancer is high in St. Louis City and Jasper County. In Iowa, excesses are seen for males in total cancer in Dubuque and Polk counties. For females, excesses are seen for total and breast cancer in Dubuque

TABLE 1

Consistently High Cancer Mortality Excess by County or County Group, 1950-1969 and 1968-1977 (1973-1977 in Kansas)

| | | | WM | WF |
|---|---|---|---|---|
| A. | Missouri | Total | St. Louis | -- |
| | | | St. Louis City | -- |
| | | Colon | St. Louis | -- |
| | | | St. Louis City | -- |
| | | Lung | St. Louis City | -- |
| | | | Jasper | -- |
| B. | Iowa | Total | Dubuque | Dubuque |
| | | | Polk | -- |
| | | Colon | -- | Lee |
| | | Breast | -- | Dubuque |
| C. | Nebraska | Total | Douglas | -- |
| | | Esophagus | SEA 2 * | -- |
| D. | Kansas | Lung | Wyandotte | -- |
| | | | Cherokee | -- |

*State Economic Area (SEA) 2 consists of Douglas and Sarpy counties combined.

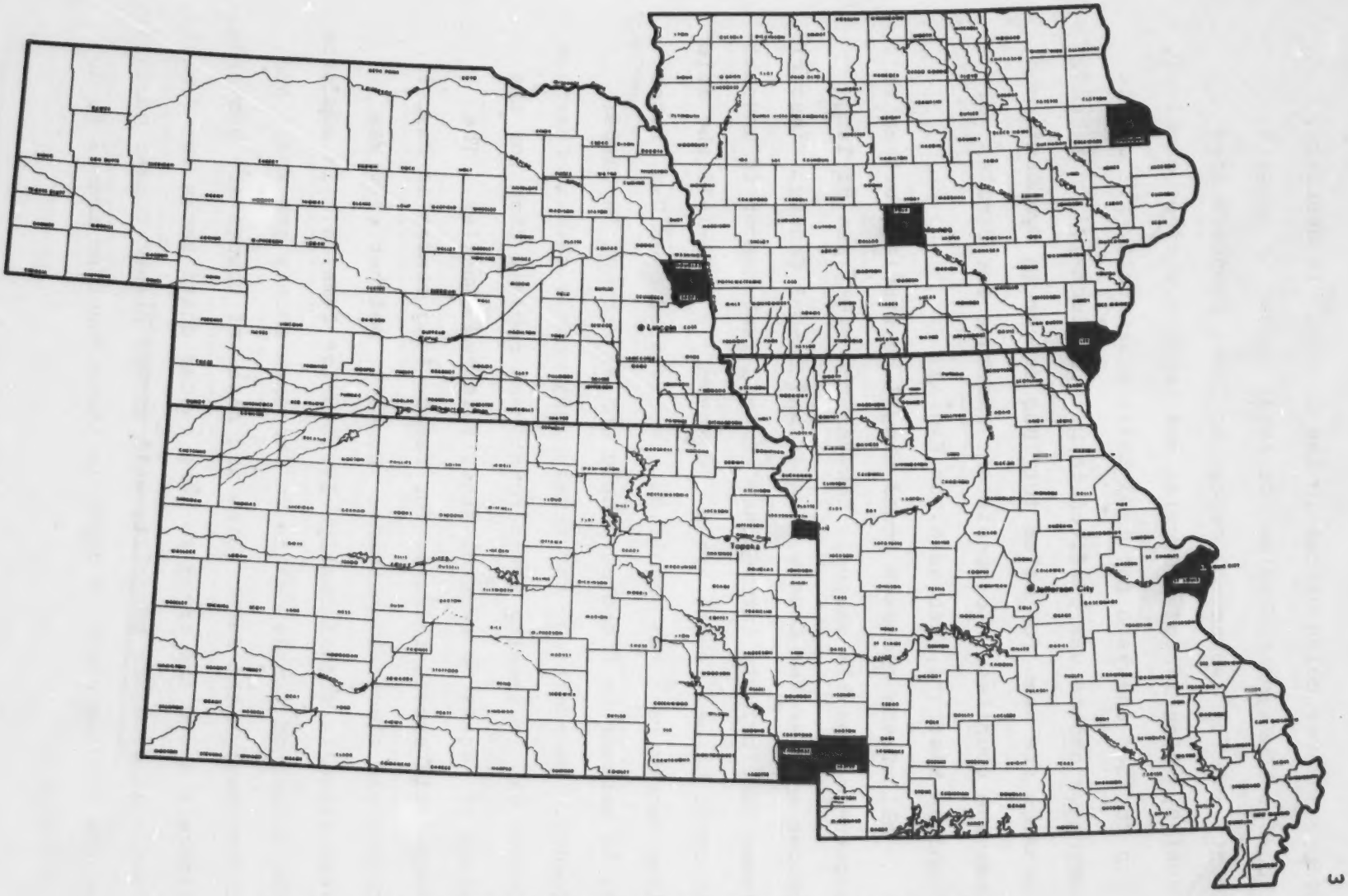



FIG. 1 CONSISTENTLY HIGH CANCER MORTALITY
EXCESS BY COUNTY OR COUNTY GROUP 1968 - 1977

County and for colon cancer in Lee County. In Nebraska, excesses are seen for males for total cancer in Douglas County and for esophageal cancer in State Economic Area (SEA) 2, which includes Douglas and Sarpy counties, combined. Upon further analysis for 1973-1977, practically all of the esophagus excess was confined to Douglas County. In Kansas, excesses are seen for males for lung cancer in Wyandotte and Cherokee counties. No consistent excesses for females were found in Missouri, Nebraska, or Kansas.

All of the excesses found should be studied further to ascertain possible causes. However the high rate of lung cancer in Cherokee County, Kansas and Jasper County, Missouri seems particularly intriguing. Excess lung cancer is unusual in rural or semi-rural areas. However, in 1973-1977 the male lung cancer rate was significantly elevated over U.S. rates by 54 percent in Cherokee County and 42 percent in Jasper County. In addition, the female lung cancer rate in Cherokee County was increasing 208 percent more rapidly than for the state of Kansas or several other selected counties. The comparable excess increase for female lung cancer in Jasper County was almost 60 percent. However, neither rate was statistically significantly elevated for females. In addition, the number of female deaths in Cherokee County are small and, consequently, the death rates and rates of change are unstable. Figure 2 shows the trend in lung cancer death rates for females. Female lung cancer mortality will exceed breast cancer mortality as the leading cause of death in these counties from 8 to 13

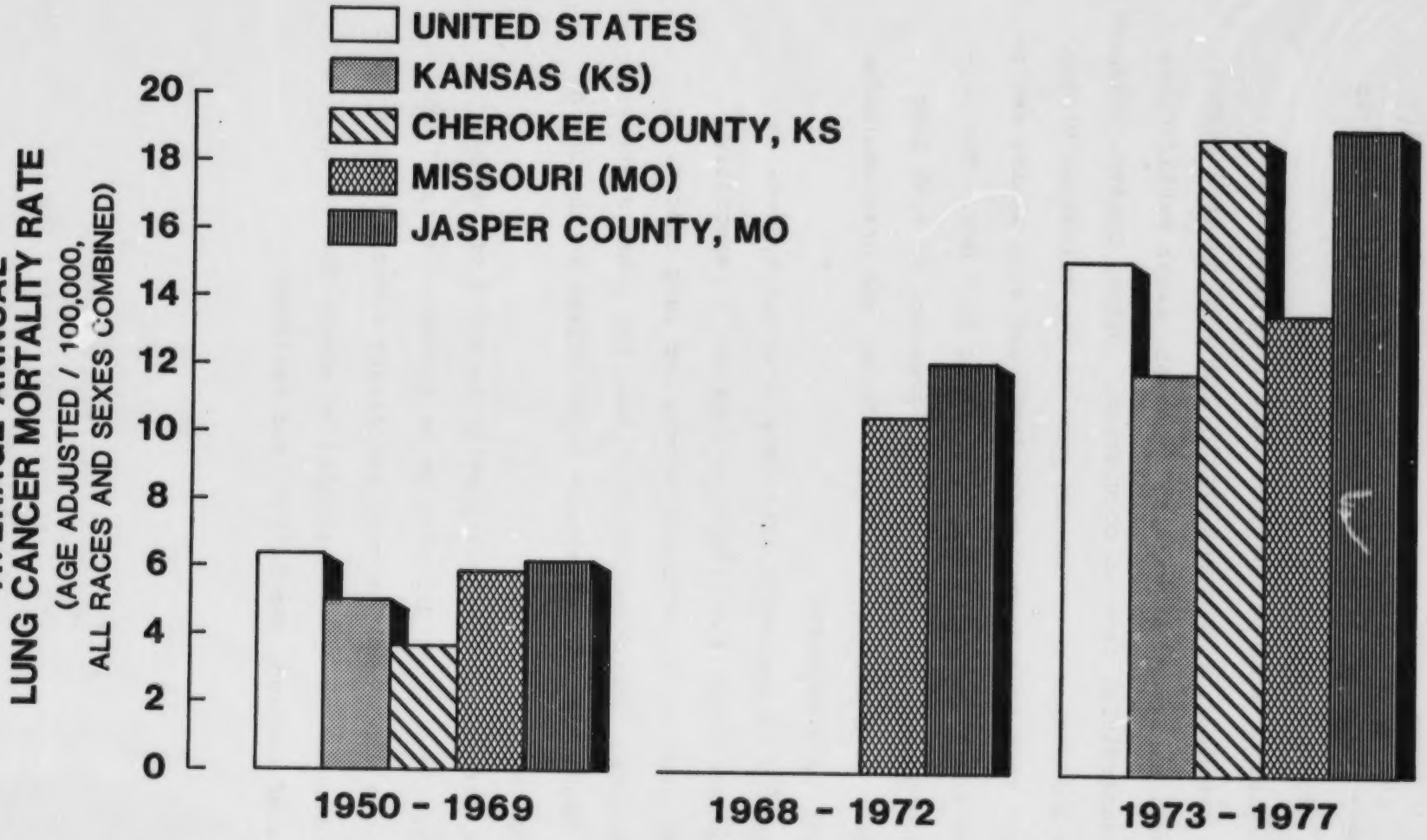



FIG. 2 **LUNG CANCER DEATH RATES IN WHITE FEMALE RESIDENTS**

years sooner than for their respective states and from 8 to 10 years sooner than for the U.S.

A review of a number of lung cancer death certificates in males residing in Cherokee County found an apparent excess of occupations listed as miners. However, death certificates provide superficial data on occupation. Ottawa County, Oklahoma, Cherokee and Jasper counties are part of the Tri-State Mining district. This is a former coal, lead, and zinc mining region with lead and zinc smelting continuing to this day. The possible occupational and environmental presence of such lung carcinogens as arsenic, asbestos, cadmium, and uranium (radon daughters) is discussed.

A review of incidence data versus mortality data in Iowa suggested that a mortality excess was a reasonably good indicator of an incidence excess for lung cancer, at least in Iowa. For other cancer sites, and other states, a greater degree of caution should be exercised in the use of mortality excess.

The data presented herein point to areas of further research. As a first priority it is suggested that if the excess lung cancer in Cherokee and Jasper counties is verified, the EPA support analytical studies to assess the relative influences of smoking, occupation, and residence.

## INTRODUCTION

Recent studies by Mason et al (1973, 1975)[1, 2] determined age adjusted cancer mortality rates for the contiguous U.S. for the period 1950-1969. Variations in cancer mortality by geographic location were quite striking. Color coded maps were used to identify cancer mortality "hot spots", and to encourage the investigation of specific cancers in counties with excessively high rates. High male to female mortality ratios suggested the need to investigate occupational exposures. For example, mortality from bladder cancer in white males is significantly elevated in industrialized areas in the Northeast, a pattern not found for females. On the other hand, high rates for both males and females suggest the possibility of cultural, genetic, or general environmental influences. Such a pattern is evident for stomach cancer in the North Central U.S. In this region are people descended from Scandinavian, German, Austrian, and Russian backgrounds. Stomach cancers are high in their countries of origin, suggesting the influence of cultural practices as well as genetic heritage.

Within Missouri, Iowa, Nebraska, and Kansas, cancer mortality rates during 1950-1969 were significantly elevated in numerous counties and for many cancer sites. For example,

several Nebraska counties showed an excess of colon cancer in white males. Esophageal cancer was elevated in white males in Douglas and Sarpy counties, combined. In Iowa, ten counties were significantly elevated for cancer of the prostate. Lung cancer rates were elevated in white males in Cherokee and Wyandotte counties in Kansas, and in Jasper and Jackson counties, and St. Louis City in Missouri.

It was thought worthwhile to recalculate the results for a more recent time period. The presence of a continuing excess might confirm that a problem continues to exist and reduce the probability that the excess is the result of a statistical fluke, less informed diagnosis, or a real but decreasing problem. Consequently, the Region VII office of the U.S. Environmental Protection Agency contracted with this investigator (EPA Contract K0575NTEX) to determine what cancer rates remained significantly elevated by county in this four state area. There are 412 counties in this region, with over 10.5 million people living within its boundaries.

This investigator was asked to fulfill the following objectives:

(1) Identify cancer mortality "hot spots" for the period 1950-1969. This utilized previously published data from Mason et al.

(2) Calculate cancer mortality rates by county for the four state region using data from 1968-1977. Determine what the new cancer mortality "hot spots" are and what "hot spots" remain consistently high over time.

(3) Calculate cancer incidence rates by county from 1969-1977 where feasible and determine what the cancer incidence "hot spots" are. How do these relate to mortality "hot spots"?

(4) Determine the extent of current research attempting to follow-up on earlier reported "hot spots."

(5) Identify which cancer "hot spots" are possibly related to environmental contaminants.

(6) Suggest further research studies needed pertinent to environmentally induced cancers. Avoid duplication of existing research.

(7) Provide results to the Region VII office of EPA in report form.

## MATERIALS AND METHODS

Cancer mortality rates were calculated for 16 cancer sites for each of the 412 counties in the region, and for 21 cancer sites for each of the 45 county groups. These county groups are the same as the U.S. Bureau of Economic Analysis' State Economic Areas; namely, one county or a group of contiguous counties with similar economic and social characteristics. The basis for grouping counties and for assigning sites to either individual county or county group was to provide consistency with the 1950-1969 study by Mason et al. The same boundaries were used for county groups as in Mason's study.

The data were restricted to white male and female residents of Missouri, Iowa, Nebraska, and Kansas. Age, sex, and race specific mortality rates were calculated using 18 age categories (0-4, 5-9 . . . 75-79, 80-84, and 85 and over). The population chosen for the denominator of the specific rates was obtained either from the 1970 U.S. census (for the 1968-1972 deaths) or from a 1975 U.S. census bureau estimate (for the 1973-1977 deaths) made available by the National Cancer Institute. Death data covered the period 1968-1977, except for Kansas, where only 1973-1977 data were used. Although data were available from Kansas

starting in 1972, the first year's deaths were eliminated herein to provide consistency with the analysis used for the other three states. The three digit death coding format for underlying cause of death was based on the International Classification of Diseases Adapted for Use in the United States, Eighth Revision (ICDA-8),[3] after checking for comparability with ICDA-6 used by Mason et al.

Cancer incidence data were obtainable at a statewide level only from Iowa. The time periods available were 1969-1971 and 1973-1977. No incidence data were collected in 1972. The data were grouped by county and county group and were otherwise treated similarly to the mortality data. The denominators used for the specific rates were the population in 1970 and 1975, respectively. Only primary site malignancies were considered. Conversion was performed to obtain similar codes to those used in the mortality study. Analysis was performed similarly for the Iowa incidence data as for the mortality data.

Age adjusted mortality and incidence rates were calculated using the direct method, applying age, sex, race and site specific county and county group rates to the total 1960 U.S. population (all races, sex specific) (Colton, 1974).[4] Rates were rank ordered for each county or county group for each selected cancer site. If the rate for a county (or county group) minus two county or county group standard deviations did not overlap with the U.S. rate plus two state standard deviations, a statistically significant

($p < 0.05$) elevated rate was indicated. Standard deviations for the 1973-1977 U.S. mortality and combined incidence rates were unavailable. Hence, state standard deviations were used as a substitute for U.S. standard deviations when comparison was made to elevated county or county group rates.

For each county and county group, comparisons were first made to the age adjusted state rate and then to the U.S. rate using 1973-1977 deaths or cases adjusted to the 1960 U.S. population (all races, sex specific). The method used was generally the same as that of Mason (Chiang, 1961),[5] except that Mason adjusted to the total 1960 U.S. population (all races, both sexes combined). Where comparison of rates between 1950-1969 and later periods was desired, the same age adjustment method was used herein as used by Mason. Since the appropriate U.S. mortality and incidence age specific rates were only available for the period 1973-1977, the U.S. age adjusted rates could only be calculated at this later time.

While mortality data are available for the entire U.S., combined incidence data was only readily available from tumor registries in the states of Connecticut, Iowa, New Mexico, Utah, and Hawaii, and the metropolitan areas of Atlanta, Detroit, New Orleans, Seattle – Puget Sound, and San Francisco – Oakland. These registries are part of the Surveillance, Epidemiology and End Results (SEER) program of the National Cancer Institute.

Counties with significantly elevated (and in the top 10 percent of rates nationally) mortality rates in 1950-1969 were first compared with the results for 1968-1972 and 1973-1977 to see if they remained significantly high. Then, counties with significantly elevated rates in either 1968-1972 or 1973-1977 were examined to see what their rates were in 1950-1969. Finally, sites significantly elevated in Iowa for mortality were compared to sites significantly elevated for incidence in order to examine the validity of using the mortality by county/county group approach.

Results are presented in three categories. Category 1 is the highest priority because it represents definitely positive findings in both 1950-1969, 1968-1972, and/or 1973-1977. Categories 2 and 3 are lower priority but could be reviewed again in the future. Category 2 results were significantly high and in the top 10 percent in 1950-1969 but, although elevated, were not significantly high in 1973-1977. Category 3 results were not significantly high and in the top 10 percent in 1950-1969 but were significantly high in 1973-1977.

Part II of this report, consisting of an Appendix, is a separate document. It contains some of the basic data used in calculating mortality and incidence rates (i.e., deaths and population by age and sex), some statewide cancer rates, male lung cancer rates in certain counties, and listings and maps of county groups (State Economic Areas).

# RESULTS

## CATEGORY 1 MORTALITY FINDINGS:

These are definitely positive findings and deserve the highest priority attention. The maximum probability of a false positive significant finding is $p < .05^2$, or $p < .0025$, assuming independence. The following requirements need to be fulfilled for Category 1.

(a) Significantly elevated and in the top 10 percent with respect to the 1950-1969 U.S. rate.

AND

(b) Above the state average in 1968-1972, with a minimum number of 6 deaths (except Kansas).

AND

(c) Significantly elevated with respect to the U.S. rate in 1973-1977, with a minimum number of 6 deaths.

For Kansas, requirement (b) is relaxed since no data is available for the period 1968-1971.

## MISSOURI

Table 2 shows that males had a continuing excess for both time periods for total and colon cancer in St. Louis County and St. Louis City and lung cancer in Jasper County and St. Louis City. Colon cancer rates were elevated 45 percent in St. Louis County and 32 percent in St. Louis City during 1973-1977. The colon cancer rates are based on 510 and 261 deaths, respectively. Lung cancer rates in males were elevated 56 percent in St. Louis City and 42 percent in Jasper County. Figure 3 shows the counties with the excess. Cancer of the lung in males was no longer significantly elevated in Jackson County. No continuing excess was shown for females.

Table 3 shows the age adjusted lung cancer mortality rates for white males in selected Missouri counties. Excess rates can be seen for St. Louis City and Jasper County in 1973-1977. The rate change in Jasper is similar to that for Boone and Buchanan but slightly greater than the state. Boone and Buchanan counties were selected because they had a similar total population to Jasper's in 1970, and were not previously involved in lead-zinc mining or smelting. Boone County has a large university population while Buchanan County is largely devoted to farming.

Table 2

Consistently Elevated Cancer
Sites in Missouri

| Sex | Site | County or County Group (SEA) | 1973-77 Ratio of Mortality Rates (age adjusted, all races, sex specific) County/U.S. | |
|---|---|---|---|---|
| Male | Total | St. Louis | 1.06 | (3,972)* |
| | | St. Louis City | 1.30 | (2,524) |
| | Colon | St. Louis | 1.45 | (510) |
| | | St. Louis City | 1.32 | (261) |
| | Lung | St. Louis City | 1.56 | (935) |
| | | Jasper | 1.42 | (190) |
| Female | | NONE | | |

*Numbers in parenthesis refer to the frequency of deaths during 1973-1977 in each County or County Group.

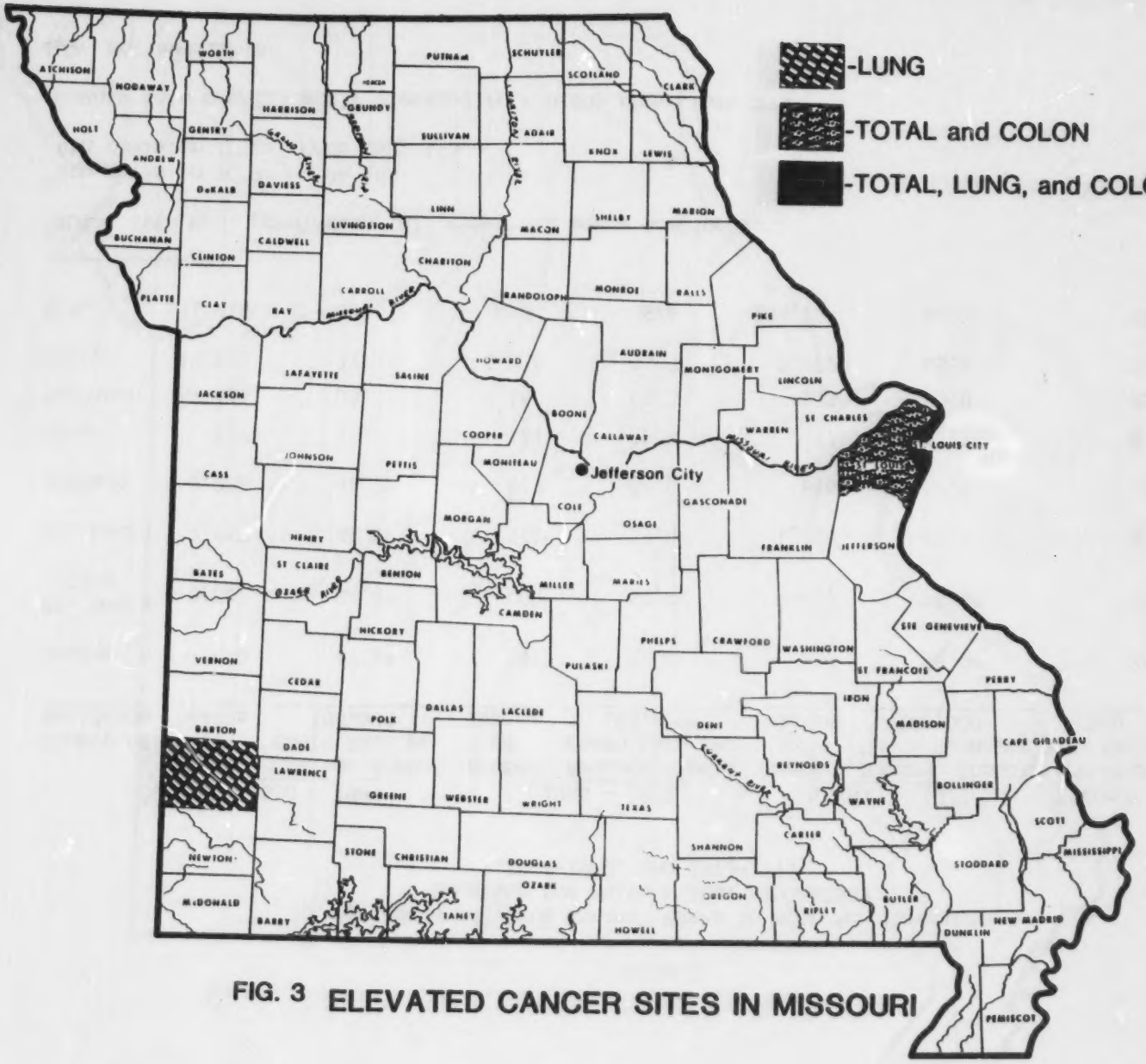



FIG. 3 ELEVATED CANCER SITES IN MISSOURI

Table 3

Age Adjusted[a] Lung Cancer[b] Rates in Selected Missouri Counties for White Males: 1950-1969, 1968-1972, and 1973-1977

| County of Residence | 1950 – 1969 Number of Deaths | 1950 – 1969 Average Annual Death Rate Per 100,000 | 1968 – 1972 Number of Deaths | 1968 – 1972 Average Annual Death Rate Per 100,000 | 1973 – 1977 Number of Deaths | 1973 – 1977 Average Annual Death Rate Per 100,000 | Percent Change in the Average Annual Death Rate Over 15 Years |
|---|---|---|---|---|---|---|---|
| Jasper | 409 | 47.2* | 161 | 72.8 | 190 | 88.0* | 86.4 |
| St. Louis City | 3,502 | 54.4* | 1,006 | 84.3 | 935 | 96.6* | 77.6 |
| St. Louis | 2,257 | 43.2 | 1,068 | 59.0 | 1,220 | 61.4 | 42.1 |
| Jackson | 2,336 | 44.7* | 843 | 64.9 | 846 | 66.9 | 49.7 |
| Boone | 127 | 30.7 | 69 | 59.3 | 77 | 57.7 | 87.9 |
| Buchanan | 414 | 39.3 | 166 | 68.3 | 175 | 73.0 | 85.8 |
| State | 15,935 | 37.3 | 6,536 | 58.3 | 7,472 | 65.0 | 74.3 |
| U.S. | 571,226 | 38.0 | N/A | N/A | 285,127 | 62.3 | 63.9 |

[a]Total 1960 U.S. population (all races and sexes combined).

[b]8th revision ICDA: Code 162.
6th revision ICDA: Code 162, 163.

*County rate significantly elevated ($p < 0.05$) above U.S. rate.

N/A Not available.

Table 4 shows the age adjusted lung cancer mortality rates for females. While the lung cancer rates for females in Jasper County are not statistically significantly elevated, they are now higher than the rates for women in St. Louis City (19.1/100,000 per year vs. 17.2/100,000 per year in 1973-1977) and are increasing 60 percent faster than the state, 47 percent faster than the U.S., and 34-43 percent faster than Boone and Buchanan counties. Lung cancer passed breast cancer as the leading cause of female cancer mortality by 1977 in Jasper County. However, lung cancer will not pass breast cancer as the leading cause of female cancer mortality for the state as a whole until 1985. Thus, the Jasper County cross-over point occurs 8 years earlier than does the state's.

Jasper County is across the border from Cherokee County, Kansas and is part of the "Tri-State Mining District," which includes this Kansas County and Ottawa County, Oklahoma. It ranks 9th in population in Missouri out of 115 counties, having a 1970 population of 78,736 whites. The average Missouri county population is 36,439, with a range from 3,353 to 903,811. The white population of Boone County numbered 76,295 in 1970. The largest city is Columbia. Buchanan County, which includes St. Joseph, had a white population of 84,263 in 1970. St. Louis City ranked third with a white population of 362,641. Jackson County ranked second, with a white population of 537,991. St. Louis County ranked first.

Table 4

Age Adjusted[a] Lung Cancer[b] Rates in Selected Missouri Counties for White Females: 1950-1969, 1968-1972, and 1973-1977

| County of Residence | 1950 – 1969 Number of Deaths | 1950 – 1969 Average Annual Death Rate Per 100,000 | 1968 – 1972 Number of Deaths | 1968 – 1972 Average Annual Death Rate Per 100,000 | 1973 – 1977 Number of Deaths | 1973 – 1977 Average Annual Death Rate Per 100,000 | Percent Change in the Average Annual Death Rate Over 15 Years |
|---|---|---|---|---|---|---|---|
| Jasper | 73 | 6.2 | 40 | 12.1 | 61 | 19.1 | 208.1 |
| St. Louis City | 564 | 6.6 | 235 | 13.1 | 253 | 17.2 | 160.6 |
| St. Louis | 458 | 7.2 | 280 | 11.8 | 428 | 16.1 | 123.6 |
| Jackson | 452 | 6.8 | 215 | 12.0 | 285 | 16.1 | 136.8 |
| Boone | 29 | 5.2 | 16 | 8.7 | 22 | 13.3 | 155.8 |
| Buchanan | 73 | 5.5 | 37 | 12.5 | 43 | 13.5 | 145.5 |
| State | 2,965 | 5.9 | 1,470 | 10.5 | 1,957 | 13.6 | 130.5 |
| U.S. | 108,326 | 6.3 | N/A | N/A | 86,455 | 15.2 | 141.3 |

[a] Total 1960 U.S. population (all races and both sexes combined).

[b] 8th revision ICDA: Code 162.
6th revision ICDA: Code 162, 163.

N/A Not Available

Lung cancer mortality rates were not significantly elevated in the old and new lead belts of Eastern Missouri during the two time periods studied. In 1950-1969, Jefferson County was significantly elevated and in the top 10 percent of rates nationally for female lung cancer. In 1973-1977, female lung cancer was non-significantly elevated (Category 2) in Jefferson County while the rate for males was significantly elevated (Category 3).

## IOWA

Table 5 shows the consistently elevated cancer mortality sites for Iowa. It is evident that there is an excess of total cancers in males in Dubuque and Polk counties and an excess of total cancers in females in Dubuque County. In addition, colon cancer is elevated 85 percent for females in Lee County (46 deaths) and female breast cancer is elevated 52 percent (106 deaths) in Dubuque County. These are shown in Figure 4.

Cancer of the prostate, which was significantly elevated in ten Iowa counties in 1950-1969, is no longer in excess at the county level.

Table 5

Consistently Elevated Cancer Sites in Iowa

| Sex | Site | County or County Group (SEA) | 1973-77 Ratio of Mortality Rates (age adjusted, all races, sex specific) County/U.S. | |
|---|---|---|---|---|
| Male | Total | Dubuque | 1.12 | (411)* |
| | | Polk | 1.11 | (1,310) |
| Female | Total | Dubuque | 1.17 | (434) |
| | Colon | Lee | 1.85 | (46) |
| | Breast | Dubuque | 1.52 | (106) |

*Numbers in parenthesis refer to the frequency of deaths during 1973-1977 in each County or County Group.

**FIG. 4 ELEVATED CANCER SITES IN IOWA**

## NEBRASKA

Table 6 and Figure 5 show the consistently elevated cancer sites in Nebraska. Males showed a continuing excess of total cancer in Douglas County and of cancer of the esophagus in State Economic Area (SEA) 2, which is Douglas and Sarpy counties combined. The amount of the esophageal cancer excess was 65 percent, and was found on further analysis to be predominantly located in Douglas County (Omaha). The total number of white male esophageal cancer deaths was 309 during 1968-1977. Of this total, 109 occurred in Douglas and Sarpy counties. Examination of death certificates of males dying of esophageal cancer revealed that approximately 10 percent had meat packing listed either as occupation or industry. The proportion of individuals previously occupied in this industry compared to Douglas County's other industries is not available at this time. Census tract analysis revealed most cases to be located on the east side of Omaha, in lower socioeconomic status tracts (Lynch et al).[6] No continuing excess was found for females.

Table 6

Consistently Elevated Cancer
Sites in Nebraska

| Sex | Site | County or County Group (SEA) | 1973-77 Ratio of Mortality Rates (age adjusted, all races, sex specific) County/U.S. | |
|---|---|---|---|---|
| Male | Total | Douglas | 1.10 | (1,656)* |
| | Esophagus | SEA 2 | 1.65 | (57) |
| Female | | NONE | | |

*Numbers in parenthesis refer to the frequency of deaths during 1973-1977 in each County or County Group.

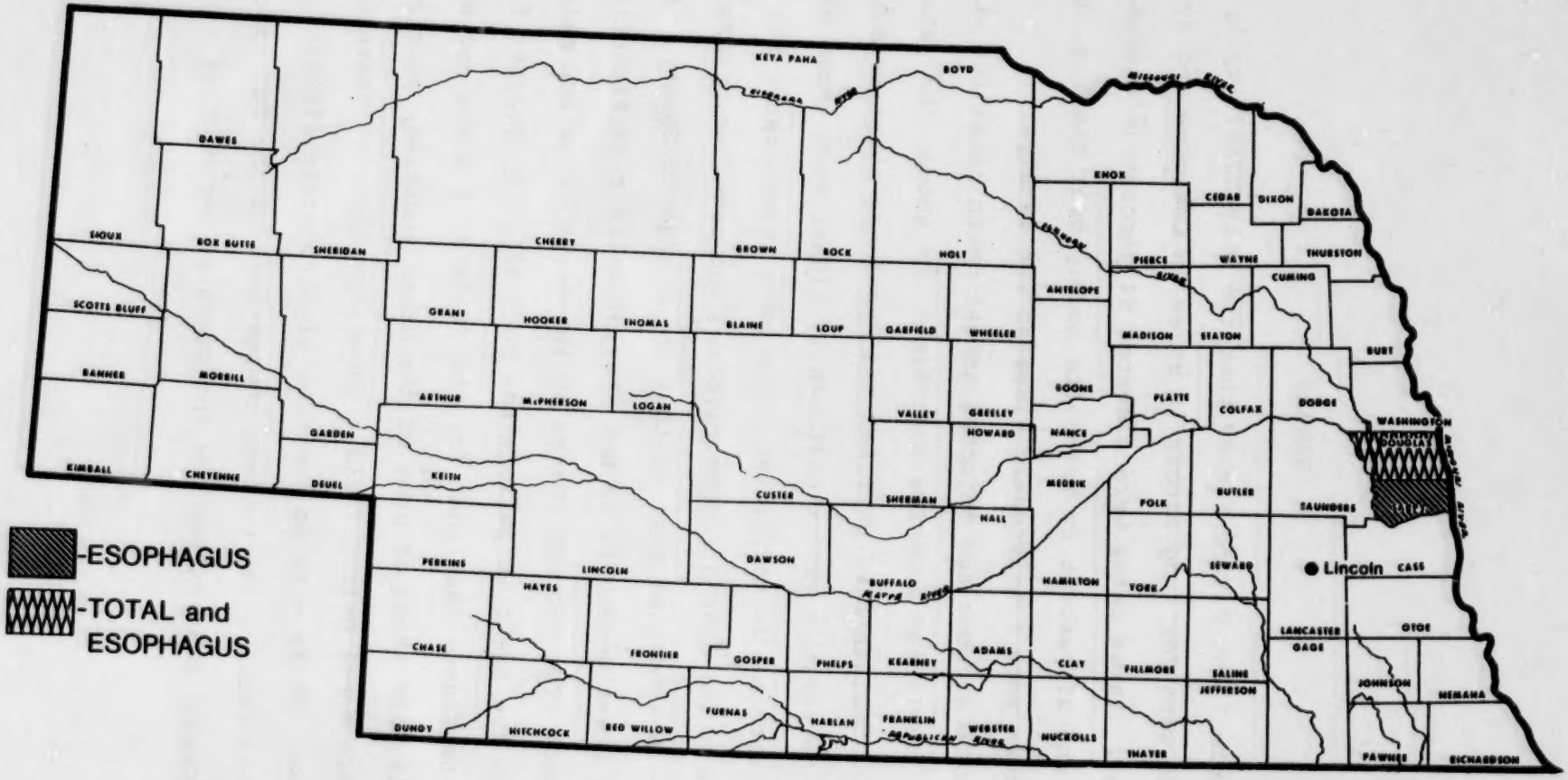



FIG. 5 ELEVATED CANCER SITES IN NEBRASKA

## KANSAS

Table 7 and Figure 6 show that the only consistently high readings were for lung cancer in males in Cherokee and Wyandotte counties. These rates were elevated 54 percent in Cherokee County and 25 percent in Wyandotte County over the U.S. average. No cancers were consistently elevated for females.

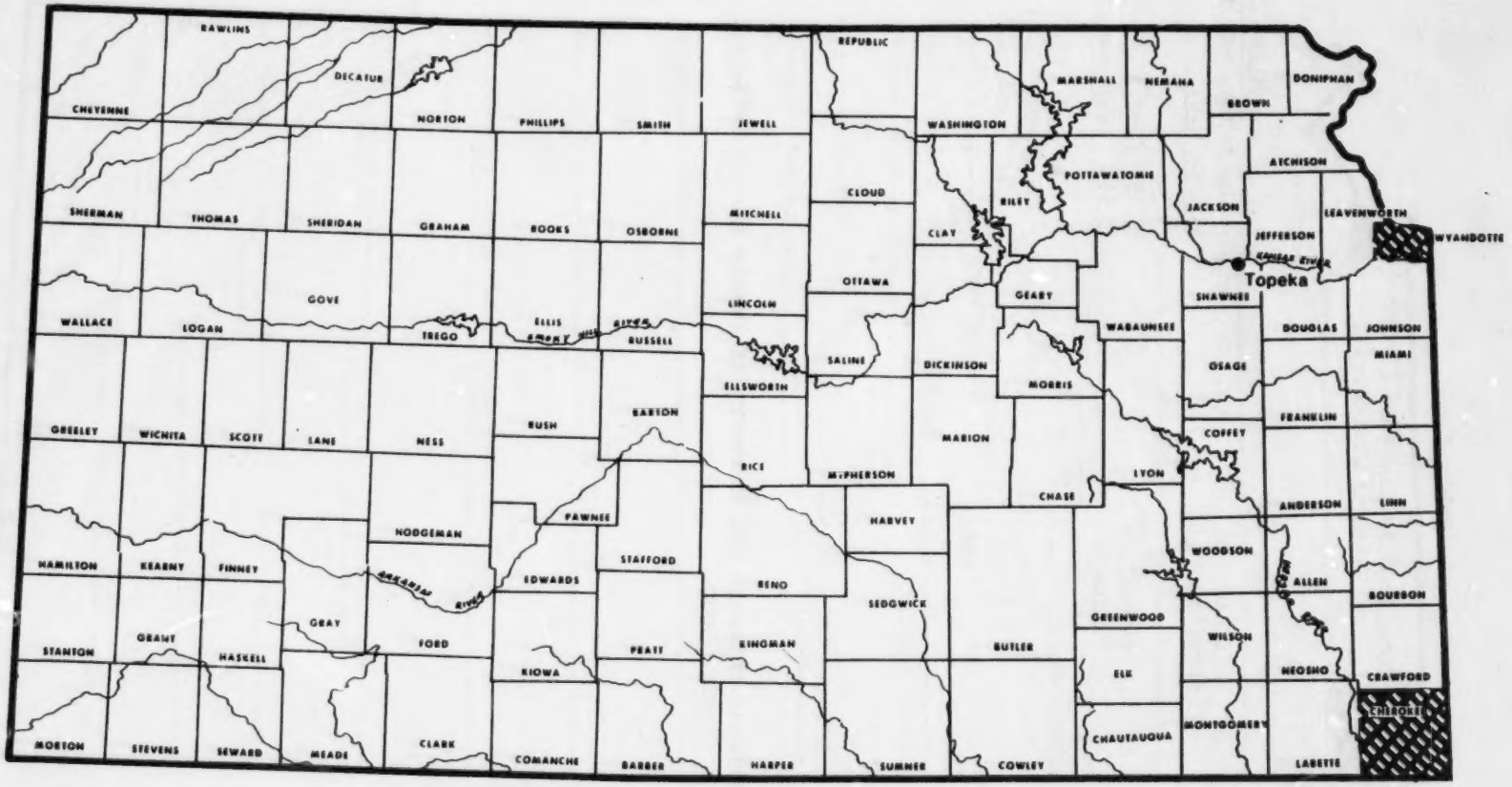
Table 8 shows age adjusted annual death rates for white males in selected counties over time. As shown, the rates for male residents of Cherokee and Wyandotte counties during both time periods were significantly higher than those of Kansas and the United States. The more recent rates are based on 65 and 258 deaths, respectively. The rate for Crawford County is almost as high as that for Wyandotte County. However, due to fewer deaths it is not statistically significantly elevated. The percent change in the death rates for males between the two time periods was only slightly greater for Cherokee County than that for the State as a whole and was comparable with those of some of the other counties, particularly the more rural ones. Table 9 shows age adjusted death rates for females. There were no counties significantly elevated. In Cherokee County, the percent change between the two time periods was greater than either for the State or for similar sized rural

Table 7

Consistently Elevated Cancer
Sites in Kansas

| Sex | Site | County or County Group (SEA) | 1973-77 Ratio of Mortality Rates (age adjusted, all races, sex specific) County/U.S. |
|---|---|---|---|
| Male | Lung | Wyandotte | 1.25 (258)* |
| | | Cherokee | 1.54 (65) |
| Female | | NONE | |

*Numbers in parenthesis refer to the frequency of deaths during 1973-1977 in each County or County Group.




-LUNG

**FIG. 6 ELEVATED CANCER SITES IN KANSAS**

TABLE 8

Age Adjusted[a] Lung Cancer[b] Rates in Selected Kansas Counties for White Males: 1950-1969 and 1973-1977

| County of Residence | 1950 - 1969 Number of Deaths | 1950 - 1969 Average Annual Death Rate Per 100,000 | 1973 - 1977 Number of Deaths | 1973 - 1977 Average Annual Death Rate Per 100,000 | Percent Change in the Average Annual Death Rate Over 15 Years |
|---|---|---|---|---|---|
| Cherokee | 125 | 47.1* | 65 | 95.6* | 103.0 |
| Crawford | 197 | 38.8 | 90 | 75.0 | 93.3 |
| Wyandotte | 610 | 45.6* | 258 | 78.0* | 71.1 |
| Sedgwick | 862 | 38.8 | 465 | 69.3 | 78.6 |
| Johnson | 296 | 31.5 | 247 | 58.1 | 84.4 |
| Shawnee | 401 | 35.1 | 193 | 60.3 | 71.8 |
| Ford | 42 | 20.3 | 26 | 47.2 | 132.5 |
| Franklin | 66 | 26.4 | 42 | 69.1 | 161.7 |
| Labette | 106 | 31.7 | 37 | 47.5 | 49.8 |
| Sumner | 95 | 30.9 | 52 | 71.7 | 132.0 |
| State | 6,206 | 29.5 | 3,276 | 57.5 | 94.9 |
| U.S. | 571,226 | 38.0 | 285,127 | 62.3 | 63.9 |

[a]Total 1960 U.S. population (all races and sexes combined).

[b]8th Revision ICDA: Code 162
6th Revision ICDA: Code 162, 163

*County rate significantly elevated ($p < 0.05$) above U.S. rate.

TABLE 9

Age Adjusted[a] Lung Cancer[b] Rates in Selected Kansas Counties for White Females: 1950-1969 and 1973-1977

| County of Residence | 1950 - 1969 Number of Deaths | 1950 - 1969 Average Annual Death Rate Per 100,000 | 1973 - 1977 Number of Deaths | 1973 - 1977 Average Annual Death Rate Per 100,000 | Percent Change in the Average Annual Death Rate Over 15 Years |
|---|---|---|---|---|---|
| Cherokee | 12 | 3.6 | 15 | 18.9 | 425.0 |
| Crawford | 26 | 4.6 | 17 | 13.4 | 191.3 |
| Wyandotte | 102 | 6.5 | 67 | 15.8 | 143.1 |
| Sedgwick | 160 | 5.8 | 113 | 12.6 | 117.2 |
| Johnson | 72 | 6.3 | 81 | 14.6 | 131.7 |
| Shawnee | 92 | 6.3 | 58 | 13.4 | 112.7 |
| Ford | 14 | 6.0 | 3 | 4.5 | -25.0 |
| Franklin | 15 | 4.9 | 10 | 11.9 | 142.9 |
| Labette | 16 | 4.2 | 10 | 9.2 | 119.0 |
| Sumner | 25 | 7.7 | 9 | 8.8 | 14.3 |
| State | 1,205 | 5.0 | 823 | 11.9 | 138.0 |
| U.S. | 108,326 | 6.3 | 86,455 | 15.2 | 141.3 |

[a] Total 1960 U.S. population (all races and both sexes combined).

[b] 8th Revision ICDA: Code 162
6th Revision ICDA: Code 162, 163

counties. The mortality rate changed from 3.6 to 18.9 per 100,000 per year in Cherokee County. Although this increase is 425 percent, which is 3 times greater than the increase of the State as a whole, it should be recognized that the number of female cases is small (12 in 1950-1969 and 15 in 1973-1977) and the death rates are consequently unstable. The sharp increase could, therefore, represent a chance occurrence.

Female breast cancer mortality rates have remained relatively constant throughout Kansas. In 1950-1969 the rate was 23.1 per 100,000 compared with 24.2 per 100,000 in 1973-1977. That represents an increase of only 4.8 percent. In Cherokee County the breast cancer mortality rates for the same two periods were 19.4 and 19.5, respectively, practically constant; these rates were among the lowest in Kansas. Thus, the rate for lung cancer was comparable to (and later exceeded) that for breast cancer (the leading cause of cancer mortality among Cherokee County women) around 1975. If present projections of a constant growth in lung cancer rates in females continue, the lung cancer rate in females would exceed the breast cancer rate by 1988 for Kansas as a whole, 13 years behind Cherokee County.

Cherokee County is rural (white population ≈ 21,000) with an occupational focus today on agricultural production (soybean, corn, wheat, and cattle). However, in the past

there was considerable mining of coal, lead, and zinc as well as lead and zinc smelting. In 1970, it ranked 23rd largest among Kansas' 105 counties. The average Kansas county population is 20,275, with a range from 1,805 to 319,322. The largest cities in Cherokee County were Baxter Springs (population about 5,100), Galena (≈3,900), and Columbus (≈3,650).

Tables 8 and 9 also list a number of other counties for comparative purposes. Wyandotte County, which consists largely of Kansas City, Kansas, is primarily "blue collar" and urban (white population ≈ 140,000). Johnson County, Kansas is a suburban county in the Kansas City metropolitan area with a white population of approximately 240,000. Sedgwick County contains Wichita, the largest city in Kansas (white population ≈ 310,000). Shawnee County contains Topeka and had a white population of approximately 143,000 in 1970. Ford County is similar in size to Cherokee County (white population ≈ 23,000), but is farming oriented and without mines. Franklin, Labette, and Sumner counties are also similar in population size to Cherokee County and are farming oriented. Crawford County is just north of Cherokee County, is an old coal mining area, and has a white population of about 37,000.

Lung cancer tends to be increased in urban areas nationwide. However, not all lung cancer excess is confined to urban areas. Thus, while it is not unusual to find the excess in urban Wyandotte County, it is unusual to find the

excess in rural Cherokee County. From the latter part of the 19th century to the 1970's, there was extensive coal, (500,000 – 1,000,000 tons per year), lead, and zinc mining in Cherokee County. Both underground and strip mining were utilized for coal, while lead and zinc mining were predominantly mined underground. Close to 2,000 men were employed during peak periods. While mining of coal, lead, and zinc per se is not considered to be a risk factor for lung cancer, the possibility of cadmium, arsenic, asbestos, or uranium contamination exists. Cadmium is a suspected lung carcinogen and is known to be present. The Kansas Geological Survey indicates (Brady, private communication) that the shale overburden in Cherokee County contains trace amounts of uranium. Tuberculosis and silicosis are commonly seen in the Tri-State mining district (Burke et al, 1979).[7] The overall tuberculosis rate in Cherokee County is elevated approximately six to seven-fold above the rate for the State. However, while there may be some additional risk for lung cancer among those with tuberculosis, this added risk is likely to be small. The synergistic effects of smoking and exposure to the silica bearing rock present may also be a factor responsible for the lung cancer excess shown. Although there is some data to support a relationship between silicosis and lung cancer, no definitive causal relationship has been proven. Lead smelting could introduce arsenic, a lung carcinogen in humans, into the environment. A lead smelter was operational in Cherokee County from 1892 until the 1960's. An asbestos

belt is believed to extend in a north-south direction through central Kansas (Levine, 1978)[8] and, if asbestos were present in the southeastern corner of the State, it could be disseminated by mining operations. Measurements have not yet been specifically made for asbestos.

Other cancer sites not significantly elevated but associated to some degree with the agents mentioned include: esophagus and pancreas (cigarette smoking), skin (arsenic), esophagus, stomach, and colon-rectum (asbestos), prostate (cadmium), and stomach and bone (ingested radium). Skin cancer is rarely fatal and so an incidence excess may not be truly represented by mortality data. Mesothelioma was not specifically coded for as a cause of death in the 8th revision of the ICDA.

To clarify the possible role of occupational association, a review of 60 death certificates of white Cherokee County residents who died of lung cancer in Kansas between 1972 and 1977 has been conducted. Summary statements of occupation for 29 additional deaths were obtained on Cherokee County residents dying in Missouri. Three death certificates were unavailable. Of the 60 lung cancer death certificates examined, 10 were female. The occupation listed for most of the women was housewife. There was no indication on the certificate of any exposure to heavy industry, including farming or mining. Of the 50 male lung cancer deaths, 13 had mining listed as industry or occupation. There were 5 laborers, 4 farmers, 3 worked for railroads, 3 in carpentry,

2 in aircraft, and 2 in oil refining. The remaining occupations were 2 or less in number. Thus, the ratio of mining to farming is 3.25. Of the 29 death certificate summaries obtained from Missouri (Dr. Carl Marienfeld, personal communication), 6 were female and indicated no specific occupational exposure to heavy industry. Of the 23 male summaries, 2 indicated exposure to mining and 2 indicated exposure to farming. Thus, the overall ratio of mining to farming is 2.50. Review of occupation/industry data from both the U.S. census and the Kansas Geological Survey reveals that the approximate percentage of men working as miners compared to those working as farmers in Cherokee County was 24 percent in 1970, 13 percent in 1960, 41-62 percent in 1950, and 78-105 percent in 1940. Although at no time since 1940 did the number of miners exceed the number of farmers in Cherokee County by more than 10 percent, the proportion of miners is much greater there than in any other part of the state. However, it should be recognized that a number of individuals may have had multiple occupations, including both farming and mining. In addition, the number of miners listed may only represent a total at some point in time and may not adequately reflect employee turnover. Death certificate data on the occupation of Jasper County, Missouri residents dying of lung cancer are currently being analyzed by investigators in that state.

## CATEGORY 2 MORTALITY FINDINGS:

These are non-positive findings but need to be closely monitored in the future because of the undoubted presence of false negatives (due to large standard deviations). This category is defined as follows:

(a) Significantly elevated and in the top 10 percent with respect to the 1950-1969 U.S. rate.

**AND**

(b) Above the state average in 1968-1972 (except Kansas).

**AND**

(c) Above the U.S. average in 1973-1977, but not statistically significant.

## MISSOURI

Table 10 shows the Category 2 results for Missouri. Rectal cancer in males is elevated non-significantly in St. Louis City by 38 percent. This rate is based on 81 deaths. Lung cancer is elevated 7 percent in Jackson County, based on 846 deaths. For females, lung cancer is non-significantly elevated 2 percent in Jefferson County (39 deaths) and cancer of the Cervix Uteri is elevated 121 percent in Pemiscot County (7 deaths) and 93 percent in Dunklin County (9 deaths).

TABLE 10

Category 2
Cancer Sites in Missouri

| Sex | Site | County or County Group (SEA) | 1973-77 Ratio of Mortality Rates (age adjusted, all races, sex specific) County/U.S. | |
|---|---|---|---|---|
| Male | Total | Jackson | 1.04 | (2,567)* |
| | Rectum | St. Louis City | 1.38 | (81) |
| | Lung | Jackson | 1.07 | (846) |
| | Other and unspecified | Sullivan | 1.34 | (6) |
| | Prostate | Lafayette | 1.13 | (20) |
| | | Harrison | 1.26 | (12) |
| | Lip | SEA 5 | 2.40 | (2) |
| | | SEA 7 | 5.60 | (3) |
| | Other mouth and throat | SEA 3 | 1.02 | (157) |
| | Esophagus | SEA 3 | 1.01 | (142) |
| | Other skin | SEA 7 | 1.45 | (7) |
| | Lymphosarcoma & reticulosarcoma | SEA 1 | 1.09 | (25) |

*Numbers in parenthesis refer to the frequency of deaths during 1973-1977 in each County or County Group.

TABLE 10 (continued)

| Sex | Site | County or County Group (SEA) | 1973-77 Ratio of Mortality Rates (age adjusted, all races, sex specific) County/U.S. | |
|---|---|---|---|---|
| Female | Stomach | Putnam | 3.66 | (6)* |
| | Colon | Clinton | 1.02 | (11) |
| | | Clark | 1.26 | (7) |
| | Liver | Washington | 1.64 | (3) |
| | | Stoddard | 1.65 | (6) |
| | Lung | Jefferson | 1.02 | (39) |
| | Other and unspecified | Stoddard | 1.23 | (14) |
| | | Wayne | 2.26 | (9) |
| | | Butler | 1.43 | (17) |
| | | Linn | 1.72 | (16) |
| | | Pemiscot | 1.20 | (10) |
| | Cervix Uteri | Pemiscot | 2.21 | (7) |
| | | Dunklin | 1.93 | (9) |
| | | Butler | 1.47 | (7) |
| | | Howell | 2.74 | (6) |
| | Corpus Uteri | Monroe | 1.39 | (2) |
| | | Grundy | 1.56 | (4) |
| | | Daviess | 2.67 | (4) |
| | Ovary | St. Louis City | 1.11 | (149) |
| | Eye | SEA 6 | 1.20 | (1) |

*Numbers in parenthesis refer to the frequency of deaths during 1973-1977 in each County or County Group.

## IOWA

Table 11 shows the Category 2 findings in Iowa. Note that three counties still have elevated prostate cancer, but that the levels are not significantly high. These include Ringgold (10 deaths), Winnebago (11 deaths), and Jasper (20 deaths) counties. The latest rate in Ringgold County is 92 percent above the U.S. average. Colon cancer for males in Lee County consists of 22 deaths and is non-significantly elevated by 1 percent. For females, colon cancer is non-significantly elevated in Clinton (34 deaths) and Clarke (12 deaths) counties but is consistently significantly high in Lee County (Category 1).

TABLE 11

Category 2
Cancer Sites in Iowa

| Sex | Site | County or County Group (SEA) | 1973-77 Ratio of Mortality Rates (age adjusted, all races, sex specific) County/U.S. |
|---|---|---|---|
| Male | Stomach | Sioux | 1.61 (10)* |
| | Colon | Lee | 1.01 (22) |
| | Liver | Crawford | 1.29 (3) |
| | Prostate | Ringgold | 1.92 (10) |
| | | Winnebago | 1.30 (11) |
| | | Jasper | 1.06 (20) |
| | Lip | SEA 12 | 1.40 (2) |
| | Multiple Myeloma | SEA 11 | 1.44 (44) |
| | Leukemia | SEA 1 | 1.18 (29) |
| | | SEA 6 | 1.16 (21) |
| | | SEA 7 | 1.05 (92) |
| | Testis | SEA 4 | 2.03 (12) |
| | | SEA 10 | 1.40 (9) |

*Numbers in parenthesis refer to the frequency of deaths during 1973-1977 in each County or County Group.

TABLE 11 (continued)

| Sex | Site | County or County Group (SEA) | 1973-77 Ratio of Mortality Rates (age adjusted, all races, sex specific) County/U.S. |
|---|---|---|---|
| Female | Total | Scott | 1.05 (539)* |
| | Colon | Clinton | 1.10 (34) |
| | | Clarke | 1.58 (12) |
| | Liver | Monroe | 1.13 (1) |
| | Breast | Crawford | 1.28 (18) |
| | Ovary | Clinton | 1.38 (20) |
| | | Dubuque | 1.53 (34) |
| | | Clay | 1.28 (8) |
| | Nasopharynx | SEA 12 | 1.40 (2) |
| | Lymphosarcoma & reticulosarcoma | SEA 4 | 1.27 (44) |

*Numbers in parenthesis refer to the frequency of deaths during 1973-1977 in each County or County Group.

## NEBRASKA

Table 12 lists Category 2 findings for Nebraska. Colon cancer in males is still elevated, though not significantly so in three counties. Elevations are 7 percent in Douglas, 6 percent in Lancaster, and 60 percent in Butler County. These rates are based on 154 deaths, 75 deaths, and 12 deaths, respectively. In females, 3 counties have elevated ratios for colon cancer. These include 19 percent in Richardson (13 deaths), 28 percent in Colfax (14 deaths), and 135 percent in Johnson (11 deaths). Total cancer for females in Douglas County is non-significantly elevated at 4 percent. Total cancer for males in Douglas County remains consistently high and is a Category 1 finding.

TABLE 12

Category 2
Cancer Sites in Nebraska

| Sex | Site | County or County Group (SEA) | 1973-77 Ratio of Mortality Rates (age adjusted, all races, sex specific) County/U.S. | |
|---|---|---|---|---|
| Male | Stomach | Dixon | 1.16 | (4)* |
| | Colon | Douglas | 1.07 | (154) |
| | | Butler | 1.60 | (12) |
| | | Lancaster | 1.06 | (75) |
| | Other mouth and throat | SEA 2 | 1.23 | (45) |
| | Thyroid | SEA 2 | 1.27 | (3) |
| | Connective Tissue | SEA 5 | 1.40 | (3) |
| | Hodgkin's Disease | SEA 2 | 1.39 | (17) |
| | Multiple Myeloma | SEA 3 | 1.30 | (12) |

*Numbers in parenthesis refer to the frequency of deaths during 1973-1977 in each County or County Group.

TABLE 12 (continued)

| Sex | Site | County or County Group (SEA) | 1973-77 Ratio of Mortality Rates (age adjusted, all races, sex specific) County/U.S. | |
|---|---|---|---|---|
| Female | Total | Douglas | 1.04 | (1,466)* |
| | Stomach | Dixon | 1.73 | (2) |
| | Colon | Colfax | 1.28 | (14) |
| | | Richardson | 1.19 | (13) |
| | | Johnson | 2.35 | (11) |
| | Breast | Burt | 1.31 | (11) |
| | Ovary | Douglas | 1.21 | (107) |
| | | Saunders | 1.69 | (10) |
| | Salivary Glands | SEA 7 | 1.80 | (2) |
| | Other Endocrine Glands | SEA 3 | 2.10 | (1) |
| | Multiple Myeloma | SEA 7 | 1.86 | (12) |

*Numbers in parenthesis refer to the frequency of deaths during 1973-1977 in each County or County Group.

## KANSAS

Category 2 results for Kansas are shown in Table 13. These include male pancreatic cancer which is elevated 84 percent above the U.S. rate in Barton County. This is based on 14 deaths. Stafford County (not shown) is now below the state and U.S. average. This is probably due to the incorrect listing of pancreatic cancer as the cause of death in Stafford County residents during 1950-1969. Upon death certificate review, approximately 50 percent of deaths attributed to pancreatic cancer could not be verified by hospital and/or other medical records (Baker et al, 1980).[9] Cherokee County is non-significantly elevated 61 percent above the U.S. rate for cancer of the cervix uteri (4 deaths).

Table 13

Category 2
Cancer Sites in Kansas

| Sex | Site | County or County Group (SEA) | 1973-77 Ratio of Mortality Rates (age adjusted, all races, sex specific) County/U.S. | |
|---|---|---|---|---|
| Male | Pancreas | Barton | 1.84 | (14)* |
| | Lip | SEA 9 | 2.60 | (2) |
| | Nasopharynx | SEA 3 | 1.47 | (3) |
| | Thyroid | SEA 3 | 1.47 | (3) |
| | Connective tissue | SEA 3 | 1.02 | (7) |
| | Leukemia | SEA 10 | 1.14 | (66) |
| Female | Cervix Uteri | Cherokee | 1.61 | (4) |
| | Corpus Uteri | Logan | 1.45 | (1) |
| | Nose, nasal cavities and sinuses | SEA 7 | 1.80 | (2) |
| | Melanoma of skin | SEA 1 | 1.07 | (15) |

*Numbers in parenthesis refer to the frequency of deaths during 1973-1977 in each County or County Group.

## CATEGORY 3 MORTALITY FINDINGS:

This category lists cancer sites which have recently increased dramatically. This may indicate future trends of importance or merely a statistical fluke (false positive). It should be recognized that a small number of deaths will lead to some instability in rates.

The criteria for inclusion in Category 3 is as follows:

(a) Not significantly elevated and in the top 10 percent with respect to the 1950-1969 U.S. rate.

AND

(b) Above the state average in 1968-1972 (except Kansas).

AND

(c) Significantly elevated with respect to the U.S. rate in 1973-1977.

## MISSOURI

Category 3 findings for Missouri are listed in Table 14. There is a 295 percent excess in kidney cancer in males in New Madrid County, which borders on the Mississippi River. However, this rate is based on only 9 deaths. In addition, brain cancer in males is elevated over three fold in Perry County (8 deaths). On the other hand, cancer of the lung in males is elevated 21 percent in Jefferson County (163 cases), 44 percent in Pemiscot County (49 cases), and 47 percent in Dunklin County (86 cases). For females, cancer of the corpus uteri is elevated 594 percent in Putnam County (8 cases) and rectal cancer is elevated 37 percent (116 cases) in St. Louis County.

Table 14

Category 3
Cancer Sites in Missouri

| Sex | Site | County or County Group (SEA) | 1973-77 Ratio of Mortality Rates (age adjusted, all races, sex specific) County/U.S. | |
|---|---|---|---|---|
| Male | Total | Buchanan | 1.21 | (571)* |
| | | Jasper | 1.20 | (509) |
| | | St. Charles | 1.12 | (358) |
| | Lung | Dunklin | 1.47 | (86) |
| | | Jefferson | 1.21 | (163) |
| | | Pemiscot | 1.44 | (49) |
| | Kidney | New Madrid | 3.95 | (9) |
| | Brain | Perry | 4.19 | (8) |
| | Other and unspecified | Jackson | 1.26 | (194) |
| | | St. Louis City | 1.33 | (154) |
| | | Cass | 1.84 | (20) |
| Female | Total | St. Louis | 1.08 | (3,669) |
| | Colon | Saline | 1.79 | (30) |
| | Other and unspecified | Barry | 2.09 | (18) |
| | Corpus Uteri | Putnam | 6.94 | (8) |
| | Rectum | St. Louis | 1.37 | (116) |

*Numbers in parenthesis refer to the frequency of deaths during 1973-1977 in each County or County Group.

## IOWA

Category 3 cancer sites for Iowa are found in Table 15. Colon cancer is increased in Franklin (males) and Dubuque (females) counties. This is based on 19 and 78 deaths, respectively. Excesses in male bladder cancer in Wright (12 deaths) and Hardin (13 deaths) counties and prostate cancer in Ida County (16 deaths) are also shown. Lung cancer in males in Polk County was significantly elevated but not in the top 10 percent nationally during 1950-1969 and was also significantly elevated above the U.S. average in 1973-1977. The rate now exceeds the U.S. average by about 17 percent. Tables 16 and 17 show lung cancer mortality trends for selected Iowa counties for males and females, respectively. The 1973-1977 rate for males in Dubuque County actually exceeds that for Polk County but it is not statistically significantly elevated due to the relatively small number of deaths. The overall rate for the state is less than that for the U.S. but the rate of increase for males for the state exceeds that for the U.S. For females, however, the absolute rate and the rate of increase is less than for the U.S. as a whole. The rate of increase in female lung cancer in Polk County exceeds that of the state by about 65 percent.

Table 15

Category 3
Cancer Sites in Iowa

| Sex | Site | County or County Group (SEA) | 1973-77 Ratio of Mortality Rates (age adjusted, all races, sex specific) County/U.S. | |
|---|---|---|---|---|
| Male | Lung | Polk | 1.17 | (442)* |
| | Colon | Franklin | 2.20 | (19) |
| | Bladder | Wright | 3.13 | (12) |
| | | Hardin | 2.41 | (13) |
| | Prostate | Ida | 2.28 | (16) |
| Female | Colon | Dubuque | 1.59 | (78) |

*Numbers in parenthesis refer to the frequency of deaths during 1973-1977 in each County or County Group.

TABLE 16

Age Adjusted[a] Lung Cancer[b] Rates in Selected Iowa Counties

For White Males: 1950-1969, 1968-1972, and 1973-1977

| County of Residence | 1950 - 1969 Number of Deaths | 1950 - 1969 Average Annual Death Rate Per 100,000 | 1968-1972 Number of Deaths | 1968-1972 Average Annual Death Rate Per 100,000 | 1973 - 1977 Number of Deaths | 1973 - 1977 Average Annual Death Rate Per 100,000 | Percent Change in the Average Annual Death Rate Over 15 Years |
|---|---|---|---|---|---|---|---|
| Polk | 987 | 43.2* | 346 | 58.4 | 442 | 72.9* | 68.8 |
| Dubuque | 267 | 38.6 | 125 | 69.0 | 139 | 73.2 | 89.6 |
| Linn | 453 | 37.2 | 194 | 59.8 | 228 | 67.6 | 81.7 |
| Pottawattamie | 315 | 40.7 | 134 | 66.5 | 141 | 69.1 | 69.8 |
| Woodbury | 383 | 34.5 | 122 | 45.5 | 171 | 64.2 | 86.1 |
| Black Hawk | 310 | 31.0 | 119 | 44.3 | 188 | 66.7 | 115.2 |
| Scott | 392 | 35.6 | 186 | 62.0 | 206 | 67.4 | 89.3 |
| State | 8,568 | 29.2 | 3,611 | 48.4 | 4,298 | 57.1 | 95.5 |
| U.S. | 571,226 | 38.0 | N/A | N/A | 285,127 | 62.3 | 63.9 |

[a] Total 1960 U.S. population (all races and sexes combined).

[b] 8th Revision ICDA: Code 162
6th Revision ICDA: Code 162, 163

*County rate significantly elevated ($p < 0.05$) above U.S. rate.

N/A Not Available

TABLE 17

Age Adjusted[a] Lung Cancer[b] Rates in Selected Iowa Counties

For White Females: 1950-1969, 1968-1972, and 1973-1977

| County of Residence | 1950 - 1969 Number of Deaths | 1950 - 1969 Average Annual Death Rate Per 100,000 | 1968-1972 Number of Deaths | 1968-1972 Average Annual Death Rate Per 100,000 | 1973 - 1977 Number of Deaths | 1973 - 1977 Average Annual Death Rate Per 100,000 | Percent Change in the Average Annual Death Rate Over 15 Years |
|---|---|---|---|---|---|---|---|
| Polk | 156 | 5.5 | 74 | 9.5 | 134 | 16.5 | 200.0 |
| Dubuque | 46 | 5.3 | 18 | 7.1 | 29 | 10.5 | 98.1 |
| Linn | 69 | 4.7 | 41 | 9.9 | 53 | 12.2 | 159.6 |
| Pottawattamie | 52 | 6.2 | 27 | 11.3 | 36 | 15.3 | 146.8 |
| Woodbury | 74 | 5.9 | 35 | 11.4 | 40 | 12.0 | 103.4 |
| Black Hawk | 55 | 4.8 | 29 | 8.8 | 52 | 14.5 | 202.1 |
| Scott | 65 | 5.1 | 39 | 10.5 | 59 | 15.8 | 209.8 |
| State | 1,571 | 4.7 | 726 | 8.0 | 962 | 10.4 | 121.3 |
| U.S. | 108,326 | 6.3 | N/A | N/A | 86,455 | 15.2 | 141.3 |

[a] Total 1960 U.S. population (all races and both sexes combined).

[b] 8th Revision ICDA: Code 162
6th Revision ICDA: Code 162, 163

N/A Not Available

## NEBRASKA

Category 3 listings for Nebraska are found in Table 18. Lung cancer in males in Douglas County was significantly elevated but not in the top 10 percent nationally in 1950-1969 and was significantly elevated above the U.S. average about 16 percent in 1973-1977. Multiple myeloma is now significantly elevated by 60 percent in SEA 2 for males, based on 35 deaths. There are no Category 3 listings for females.

Tables 19 and 20 show lung cancer mortality trends for selected Nebraska counties for males and females, respectively. For comparative purposes, the state rate for white male lung cancer is about 20 percent lower than the U.S. rate. Although Dakota County had the same white male lung cancer mortality rate as Douglas County in 1950-1969 its rate was not significantly elevated because it had fewer cases (47 versus 1,223). In 1973-1977, Dakota County's rate was elevated about 16 percent above that for the U.S. Again, because of fewer cases than Douglas County (23 versus 562) its rate was not significantly elevated.

For males, the rates of increase of lung cancer mortality over 15 years for the selected counties are similar to that of the U.S., although the rate of increase for the

Table 18

Category 3
Cancer Sites in Nebraska

| Sex | Site | County or County Group (SEA) | 1973-77 Ratio of Mortality Rates (age adjusted, all races, sex specific) County/U.S. | |
|---|---|---|---|---|
| Male | Lung | Douglas | 1.16 | (562)* |
| | Multiple myeloma | SEA 2 | 1.60 | (35) |
| Female | | NONE | | |

*Numbers in parenthesis refer to the frequency of deaths during 1973-1977 in each County or County Group.

TABLE 19

Age Adjusted[a] Lung Cancer[b] Rates in Selected Nebraska Counties

For White Males: 1950-1969, 1968-1972, and 1973-1977

| County of Residence | 1950 - 1969 Number of Deaths | 1950 - 1969 Average Annual Death Rate Per 100,000 | 1968-1972 Number of Deaths | 1968-1972 Average Annual Death Rate Per 100,000 | 1973 - 1977 Number of Deaths | 1973 - 1977 Average Annual Death Rate Per 100,000 | Percent Change in the Average Annual Death Rate Over 15 Years |
|---|---|---|---|---|---|---|---|
| Douglas | 1,223 | 42.5* | 456 | 59.8 | 562 | 72.6* | 70.8 |
| Dakota | 47 | 42.5 | 25 | 82.9 | 23 | 72.1 | 69.6 |
| Lancaster | 383 | 29.6 | 155 | 44.9 | 172 | 47.9 | 61.8 |
| Sarpy | 53 | 33.8 | 38 | 63.7 | 34 | 52.7 | 55.9 |
| Hall | 132 | 33.3 | 62 | 54.9 | 80 | 54.3 | 63.1 |
| State | 4,142 | 27.7 | 1,701 | 43.5 | 1,956 | 49.5 | 78.7 |
| U.S. | 571,226 | 38.0 | N/A | N/A | 285,127 | 62.3 | 63.9 |

[a]Total 1960 U.S. population (all races and sexes combined).

[b]8th Revision ICDA: Code 162
6th Revision ICDA: Code 162, 163

*County rate significantly elevated ($p < 0.05$) above U.S. rate.

N/A Not Available

TABLE 20

Age Adjusted[a] Lung Cancer[b] Rates in Selected Nebraska Counties

For White Females: 1950-1969, 1968-1972, and 1973-1977

| County of Residence | 1950 - 1969 Number of Deaths | 1950 - 1969 Average Annual Death Rate Per 100,000 | 1968-1972 Number of Deaths | 1968-1972 Average Annual Death Rate Per 100,000 | 1973 - 1977 Number of Deaths | 1973 - 1977 Average Annual Death Rate Per 100,000 | Percent Change in the Average Annual Death Rate Over 15 Years |
|---|---|---|---|---|---|---|---|
| Douglas | 197 | 5.8 | 100 | 10.1 | 182 | 17.6 | 203.4 |
| Dakota | 7 | 6.1 | 4 | 11.9 | 6 | 13.4 | 119.7 |
| Lancaster | 99 | 5.8 | 29 | 6.1 | 56 | 11.4 | 96.6 |
| Sarpy | 5 | 2.8 | 3 | 4.7 | 14 | 15.1 | 439.3 |
| Hall | 18 | 3.9 | 10 | 7.5 | 13 | 9.0 | 130.8 |
| State | 793 | 4.7 | 327 | 7.1 | 508 | 10.7 | 127.7 |
| U.S. | 108,326 | 6.3 | N/A | N/A | 86,455 | 15.2 | 141.3 |

[a]Total 1960 U.S. population (all races and both sexes combined).

[b]8th Revision ICDA: Code 162
6th Revision ICDA: Code 162, 163

N/A Not Available

state as a whole is somewhat higher than the U.S. (78.7 percent versus 63.9 percent).

For females, Douglas County is above the state and U.S. average but not significantly. The rates of increase are not too dissimilar from that of the U.S. except for Lancaster County, which is low, and Douglas and Sarpy counties which are high. The rate of increase in females in Sarpy county is 210 percent greater than that of the U.S., with the greatest part of the increase occurring in the 1973-1977 period. This latter rate is, however, based on only 14 deaths, with corresponding rate instability. For males, the rate of increase in Sarpy County is below that of the U.S.

## KANSAS

Category 3 listings for Kansas are found in Table 21. In Butler County, male kidney cancer is now elevated 160 percent above the U.S. average. This is based on 13 deaths. In Shawnee County, male bladder cancer is now elevated 72 percent over the U.S. average (39 deaths). Pancreatic cancer is now 194 percent above the U.S. average in males in Atchison County (13 deaths). No new significant excesses are found for females.

Table 21

Category 3
Cancer Sites in Kansas

| Sex | Site | County or County Group (SEA) | 1973-77 Ratio of Mortality Rates (age adjusted, all races, sex specific) County/U.S. | |
|---|---|---|---|---|
| Male | Total | Wyandotte | 1.17 | (744)* |
| | | Barton | 1.21 | (187) |
| | | Marshall | 1.24 | (129) |
| | Stomach | Jackson | 3.40 | (10) |
| | Kidney | Butler | 2.60 | (13) |
| | Bladder | Shawnee | 1.72 | (39) |
| | Pancreas | Atchison | 2.94 | (13) |
| | Other skin | SEA 5 | 4.73 | (10) |
| | Leukemia | SEA 5 | 1.88 | (33) |
| | Lymphosarcoma and reticulosarcoma | SEA 11 | 1.84 | (29) |
| Female | N O N E | | | |

*Numbers in parenthesis refer to the frequency of deaths during 1973-1977 in each County or County Group.

# DISCUSSION

## Risk Factors

The only consistently statistically significantly elevated (and in the top 10 percent nationally in 1950-1969) mortality rates found within the region during both time periods were total cancer and cancer of the colon, lung, breast and esophagus. Possible risk factors among whites for these cancers (other than increasing age) include (Fraumeni, 1975):[10]

1. Total (three digit ICDA-8 code: 140-209)

   This category is too broad for the assignment of specific risk factors. Major contributors are lung, prostate, and colon cancer for males and breast, colon, and lung cancer for females.

2. Colon (153)

   Risk factors for this cancer site include foods low in fiber and high in animal protein and fat, nitrosamines, ulcerative colitis, vitamin A deficiency, familial multiple adenomatous polyposis coli, hereditary non-polyposis coli (cancer family syndrome), and hereditary site specific colon cancer. Immigrants from Ireland may be at higher risk.

3. Lung (162)

This is the most common tumor related to an airborne environmental determinant. Risk factors include:

(a) cigarette smoking
(b) arsenic
(c) sulfur dioxide (co-carcinogen)
(d) asbestos
(e) bis (chloromethyl) ether
(f) cadmium
(g) chromium
(h) hematite
(i) nickel
(j) polycyclic aromatic hydrocarbons (soot and tars)
(k) vinyl chloride
(l) uranium (radon daughters)
(m) petroleum refining
(n) mustard gas
(o) pulmonary fibrosis (e.g., scarring from tuberculosis)

4. Breast (174)

Risk factors for females include obesity, familial or personal history of breast cancer, menstrual onset before age 10, menopause after age 50, high socioeconomic status, ionizing radiation, first full term pregnancy over age 30, nulliparity, and benign breast disease.

5. Esophagus (150)

Risk factors include cigarette smoking, alcohol (content > 12 percent or contaminated), low vegetable and fruit intake, nitrosamines, and tannins (coloring or dyeing agents). Individuals of Irish and Polish first generation may be susceptible.

Methodology

Unlike the 1950-1969 NCI study, this investigation used Code 162 for lung cancer, and did not include Code 163. Code 163 is unspecified as to primary or secondary site in the 6th revision. There is good comparability in death certificate coding for primary site lung cancer between the time periods studied. The population used herein was that measured in 1970 and/or estimated for 1975, not the sum of the twenty year's population used by NCI. The principal method of age adjustment used was sex specific, although when comparison was made to Mason's data both sexes were combined. By so combining, rates for males are increased since there are more females in the older age groups. Conversely, this approach also decreases the rates for females. It would be useful to obtain the 1973-1977 cancer rates needed to qualify each site to be in the top 10 percent nationally. Although such rates have been calculated herein for each state, they are not readily available for the entire U.S.

The approach used in this study is a conservative one. Cancer sites remaining statistically significantly elevated in both time periods ($p < 0.05$ in both 1950-1969 and 1973-1977 equals $p < 0.05^2$, or $p < 0.0025$, assuming independence) were considered to be high priority for further research on possible causation. This probably is not the most useful method for identifying excesses of the rarest tumors since deaths over a five year period may yield too few cases in a given county or county group, resulting in a large standard deviation. The acquisition of national standard deviations for the period 1973-1977 would also be desirable. The use of each State's standard deviation as a substitute may create false negatives.

Validity

One might question the degree to which a mortality rate excess in this study is a reliable indicator of an incidence rate excess. Incidence data are preferred because they are a better measure of risk than mortality, particularly for cancers with a low case fatality rate. However, only one of the four states – Iowa – has incidence data available for the entire population of the state. This incidence data has been verified by review of histology, x-ray and other medical records by an auditor trained at the State Health Registry of Iowa. In addition, quality control is performed by the National Cancer Institute.

Because of the availability of incidence data from the Surveillance, Epidemiology and End Results (SEER) program for 1973-1977, it was decided to compare the 1973-1977 excess of county/county group unverified mortality rates over the U.S. mortality average with the 1973-1977 excess of county/county group incidence rates over the SEER average. This was called the external comparison. In addition, an internal comparison to the Iowa state average for both incidence and mortality was performed because the SEER data may not be representative of the total U.S.

The procedure for the comparison using Iowa data was:

(1) Mortality rates had to exceed the state average in 1968-1972, be statistically significantly elevated above the state or U.S. mortality average in 1973-1977, and consist of 6 or more deaths in each time period.

(2) Incidence rates had to exceed the state average in 1969-1971, be statistically significantly elevated above the state or SEER incidence average in 1973-1977, and consist of 6 or more cases in each time period.

The following tables show the results for counties and county groups for cancer sites significantly elevated. The tables also present data on the ratio of mortality or incidence rates and the frequency of deaths or new cases. Using the external comparison (Tables 22 and 23), the only consistent findings are for lung cancer in males in Polk County (531 cases and 442 deaths) and for colon cancer in females in Lee County (68 cases and 46 deaths). Using the internal comparisons (Tables 24 and 25), the only consistent findings for males were: Total in Polk, Scott, and Linn counties; and lung in Linn and Polk counties. For females, the consistent findings were: Total in Scott, lung in Polk (141 cases, 134 deaths), and colon in Lee County.

Cancers that were elevated in incidence in males for both the external and internal comparisons that were not detected in either mortality comparison were total cancer in Buchanan County (231 cases), rectal cancer in Scott County (75 cases), cancer of the prostate in Tama County (61 cases), and cancer of the testis in SEA 8 (36 cases). For females, excess cancer of the cervix uteri in Scott County (69 cases) was undetected in either of the mortality findings.

The external comparison for mortality correctly identified 50 percent of the counties with excess lung cancer incidence in males. In addition, this comparison correctly identified one county for colon cancer in females. Using

TABLE 22

Elevated Cancer Mortality
Sites in Iowa,
1973-1977
(External Comparison)

| Sex | Site | County or County Group (SEA) | 1973-77 Ratio of Mortality Rates (age adjusted, all races, sex specific) County/U.S. | |
|---|---|---|---|---|
| Male | Total | Dubuque | 1.12 | (411)* |
| | | Polk | 1.11 | (1,310) |
| | Lung | Polk | 1.17 | (442) |
| | Colon | Franklin | 2.20 | (19) |
| | Bladder | Hardin | 2.41 | (13) |
| | Prostate | Ida | 2.28 | (16) |
| Female | Total | Dubuque | 1.17 | (434) |
| | Colon | Lee | 1.85 | (46) |
| | | Dubuque | 1.59 | (78) |
| | Breast | Dubuque | 1.52 | (106) |

*Numbers in parenthesis refer to the frequency of deaths during 1973-1977 in each County or County Group.

TABLE 23

Elevated Cancer Incidence
Sites in Iowa,
1973-1977
(External Comparison)

| Sex | Site | County or County Group (SEA) | 1973-77 Ratio of Incidence Rates (age adjusted, all races, sex specific) County/U.S. | |
|---|---|---|---|---|
| Male | Total | Buchanan | 1.18 | (231)* |
| | Rectum | Scott | 1.39 | (75) |
| | Lung | Linn | 1.19 | (293) |
| | | Polk | 1.18 | (531) |
| | Prostate | Tama | 1.39 | (61) |
| | Testis | SEA 8 | 1.70 | (36) |
| | Lip | SEA 12 | 1.71 | (58) |
| Female | Colon | Lee | 1.51 | (68) |
| | Cervix Uteri | Scott | 1.71 | (69) |
| | | Woodbury | 1.48 | (48) |
| | | Muscatine | 1.93 | (21) |

*Numbers in parenthesis refer to the frequency of cases during 1973-1977 in each County or County Group.

TABLE 24

Elevated Cancer Mortality
Sites in Iowa,
1973-1977
(Internal Comparison)

| Sex | Site | County or County Group (SEA) | 1973-77 Ratio of Mortality Rates (age adjusted, all races, sex specific) County/Iowa | |
|---|---|---|---|---|
| Male | Total | Iowa | 1.24 | (108)* |
| | | Dubuque | 1.16 | (411) |
| | | Polk | 1.16 | (1,310) |
| | | Scott | 1.12 | (639) |
| | | Linn | 1.09 | (689) |
| | Lung | Dubuque | 1.28 | (139) |
| | | Linn | 1.19 | (228) |
| | | Polk | 1.27 | (442) |
| | Colon | Franklin | 2.02 | (19) |
| | Bladder | Hardin | 2.41 | (13) |
| | Prostate | Ida | 2.04 | (16) |
| Female | Total | Dubuque | 1.24 | (434) |
| | | Scott | 1.11 | (539) |
| | | Lee | 1.19 | (213) |
| | Lung | Polk | 1.58 | (134) |
| | | Scott | 1.51 | (59) |
| | Colon | Lee | 1.67 | (46) |
| | | Dubuque | 1.43 | (78) |
| | Breast | Dubuque | 1.57 | (106) |

*Numbers in parenthesis refer to the frequency of deaths during 1973-1977 in each County or County Group.

TABLE 25

Elevated Cancer Incidence
Sites in Iowa,
1973-1977
(Internal Comparison)

| Sex | Site | County or County Group (SEA) | 1973-77 Ratio of Incidence Rates (age adjusted, all races, sex specific) County/Iowa | |
|---|---|---|---|---|
| Male | Total | Buchanan | 1.33 | (231)* |
| | | Linn | 1.19 | (1,255) |
| | | Polk | 1.17 | (2,206) |
| | | Benton | 1.14 | (243) |
| | | Black Hawk | 1.07 | (941) |
| | | Scott | 1.13 | (1,072) |
| | Rectum | Scott | 1.49 | (75) |
| | Lung | Linn | 1.34 | (293) |
| | | Polk | 1.33 | (531) |
| | | Scott | 1.24 | (247) |
| | Bladder | Polk | 1.24 | (166) |
| | Other and unspecified | Polk | 1.36 | (111) |
| | Prostate | Tama | 1.56 | (61) |
| | | Wright | 1.54 | (54) |
| | | Black Hawk | 1.27 | (190) |
| | Testis | SEA 8 | 1.78 | (36) |
| Female | Total | Muscatine | 1.19 | (361) |
| | | Marshall | 1.18 | (382) |
| | | Linn | 1.12 | (1,262) |
| | | Scott | 1.12 | (1,065) |
| | Colon | Lee | 1.53 | (68) |
| | Lung | Clinton | 1.74 | (35) |
| | | Polk | 1.40 | (141) |
| | Breast | Mahaska | 1.36 | (76) |
| | Cervix Uteri | Scott | 1.51 | (69) |
| | Corpus Uteri | Butler | 1.85 | (25) |
| | | Story | 1.49 | (53) |
| | | Linn | 1.28 | (129) |

*Numbers in parenthesis refer to the frequency of cases during 1973-1977 in each County or County Group.

the internal comparison some congruency is seen for total, lung, and colon cancer. Internal comparisons reveal greater congruency than do external comparisons, which is expected.

This comparison in Iowa may provide some support to the validity of using mortality excess as an indicator of incidence excess, particularly for lung cancer, and possibly for colon and total cancer. Considerable caution needs to be exercised, however, in using this approach. Verification of cancer mortality is needed in each State. In addition, there is a need for national incidence rates in order for proper external comparisons to be made. The generalizability of the results in Iowa to the other states in the region is uncertain. It might prove useful to review data from the other SEER registries for comparative purposes.

## Conclusion

This county based study has found an excess of colon and lung cancer in Missouri males, colon and breast cancer in Iowa females, esophageal cancer in Nebraska males, and lung cancer in Kansas males. All of these excesses should be considered for further study. The lung cancer excess in males in Cherokee County, Kansas and Jasper County, Missouri is particularly intriguing. Men in both counties were formerly heavily involved in the mining and smelting of lead and zinc. The potential for an environmental carcinogen now present should not be ignored. Mine tailings have been used extensively in surfacing roads, sandblasting, and as railroad ballast. Piles of these tailings dot the landscape.

Debris from numerous strip mines still can be found. Surface waters may be contaminated by tailings runoff. Lung cancer death rates in females are increasing more rapidly than expected in these two counties and have passed breast cancer, the leading cause of female cancer mortality, sooner than expected. The new lung cancer rates for females in these two counties are higher than the U.S. average, but not significantly so. It should be stressed, however, that the female lung cancer rates are based on small numbers and could be unstable. Thus, the rate changes could be due to chance. While death certificates examined for male Cherokee County residents indicated a larger number than expected were involved in mining, the female lung cancer death certificates indicated no such direct industrial exposure. There are problems, however, in relying on death certificates for occupational information.

Additional mortality data has been obtained from the Epidemiology Branch of the Environmental Protection Agency (John Acquavella, personal communication to Mr. John Mandia of the Region VII office of EPA, November, 1980) concerning this study. Acquavella abstracted data from EPA's mortality trend atlas (due for publication in the Fall of 1981) concerning Missouri, Oklahoma, and Kansas. For the 1970-1977 period this data shows that the lung cancer mortality rate for white males was significantly elevated above the U.S. rate for all three counties. Cherokee County was in the top 3 percent of rates nationally while Ottawa County was in the top 7 percent. Jasper County was in the top 13 percent. For

white females, Jasper and Ottawa counties were significantly elevated above the U.S. rate while Cherokee County was not. The corresponding county rate percentiles were top 8 percent, top 5 percent, and top 12 percent, nationally. Acquavella discounts the importance of the excess in female rates because of the instability of rates based on small numbers.

Assuming that the lung cancer deaths are verified, the data suggest either an excess in cigarette smoking, the influence of pulmonary fibrosis, some relationship between cigarette smoking and pre-existing lung disease (e.g., tuberculosis), the presence of one or more occupational/environmental carcinogens or co-carcinogens, or some other factor or factors at work in Cherokee and Jasper counties. If an environmental carcinogen is involved, it is possible that it was formerly confined to the workplace (e.g., the mines) and was or is out in either the general environment or the home. It is likely that any lung carcinogen would be acting synergistically with cigarette smoking. It should be emphasized, however, that the cause of the excess lung cancer in the Tri-State region is unknown and that the above speculations remain to be proven.

There is a need for analytic epidemiology studies in the Tri-State Mining District (including Ottawa County, Oklahoma) to assess the influence of smoking, occupation, and residence on the excess lung cancer mortality rate. Verification of the underlying cause of death as stated on the death certificate is essential. Additional environmental

sampling in the Tri-State District may be warranted. Comparisons could be made to counties in the old and new lead belts of Missouri. Specific agents of highest priority might include arsenic (air, soil, and water), asbestos (mine tailings), and radon daughters (air and water associated with mine tailings and strip mine pits). It might be appropriate for the Environmental Protection Agency to support additional studies because the excess lung cancer may not be related exclusively to occupation or smoking.

## ADDENDUM

Computer tapes provided by the state health agencies and the State Health Registry of Iowa remain the property of those agencies on permanent loan to this investigator. These tapes contain varying degrees of individual identification and other personal information and thus are considered confidential, and unavailable for review.

Computer printouts containing results obtained under this contract hereby become the property of the U.S. Environmental Protection Agency. However, this material will also remain on permanent loan to this investigator. Besides the immediate parties involved, responsible individuals and/or organizations with a need to know will be allowed to review this material. Although not confidential, cancer data for specific counties is of a sensitive nature. Permission for such review must first be granted by either Mr. Wolfgang Brandner, Mr. John Wicklund, or some other representative of the Region VII office of EPA designated by them. Additional approval must be obtained from the respective state agencies. Copies of some of these printouts have been previously submitted to selected individuals (see Acknowledgement) within each of the respective cooperating agencies. These individuals have agreed not to release any of this data without the

prior approval of this investigator.

All other materials, including any duplicate copies of computer printouts, remain the property of this investigator, who reserves the right to publish any summary results while maintaining the confidentiality of individuals.

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Statistical consultation was provided by Gary M. Clark, Ph.D., formerly Associate Professor, Department of Biometry, School of Allied Health, University of Kansas College of Health Sciences and Hospital (now Research Associate Professor of Medicine, Division of Clinical Oncology, University of Texas Health Sciences Center, San Antonio, Texas). Computer programming was provided by Mr. Edward Brown and Ms. Debby Burnside, Department of Biometry, School of Allied Health, University of Kansas College of Health Sciences and Hospital.

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Mr. Wolfgang Brandner, Chief, Toxics Section, Toxics and Pesticides Branch, Region VII, U.S. Environmental Protection Agency, reviewed early draft copies of this report

and provided editorial guidance. He also allowed access of this investigator to topographic maps and aerial photographs of the Tri-State Mining District compiled by another contractor to the Region VII office.

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